# Model 7067 4-Wire Scanner Card

## Instruction Manual

Contains Operating and Servicing Information

KEITHLEY

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# Model 7067 4-Wire Scanner Card Instruction Manual

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# SAFETY PRECAUTIONS

The following safety precautions should be observed before using this product and any associated instrumentation. Although some instruments and accessories would normally be used with non-hazardous voltages, there are situations where hazardous conditions may be present.

This product is intended for use by qualified personnel who recognize shock hazards and are familiar with the safety precautions required to avoid possible injury. Read the operating information carefully before using the product.

Exercise extreme caution when a shock hazard is present. Lethal voltage may be present on cable connector jacks or test fixtures. The American National Standards Institute (ANSI) states that a shock hazard exists when voltage levels greater than 30V RMS, 42.4V peak, or 60VDC are present. **A good safety practice is to expect that hazardous voltage is present in any unknown circuit before measuring.**

Before operating an instrument, make sure the line cord is connected to a properly grounded power receptacle. Inspect the connecting cables, test leads, and jumpers for possible wear, cracks, or breaks before each use.

For maximum safety, do not touch the product, test cables, or any other instruments while power is applied to the circuit under test. ALWAYS remove power from the entire test system and discharge any capacitors before: connecting or disconnecting cables or jumpers, installing or removing switching cards, or making internal changes, such as installing or removing jumpers.

Do not touch any object that could provide a current path to the common side of the circuit under test or power line (earth) ground. Always make measurements with dry hands while standing on a dry, insulated surface capable of withstanding the voltage being measured.

Do not exceed the maximum signal levels of the instruments and accessories, as defined in the specifications and operating information, and as shown on the instrument or test fixture rear panel, or switching card.

Do not connect switching cards directly to unlimited power circuits. They are intended to be used with impedance limited sources. NEVER connect switching cards directly to AC main. When connecting sources to switching cards, install protective devices to limit fault current and voltage to the card.

When fuses are used in a product, replace with same type and rating for continued protection against fire hazard.

Chassis connections must only be used as shield connections for measuring circuits, NOT as safety earth ground connections.

If you are using a test fixture, keep the lid closed while power is applied to the device under test. Safe operation requires the use of a lid interlock.

If a ⏚ screw is present on the test fixture, connect it to safety earth ground using #18 AWG or larger wire.

The ⚡ symbol on an instrument or accessory indicates that 1000V or more may be present on the terminals. Refer to the product manual for detailed operating information.

Instrumentation and accessories should not be connected to humans.

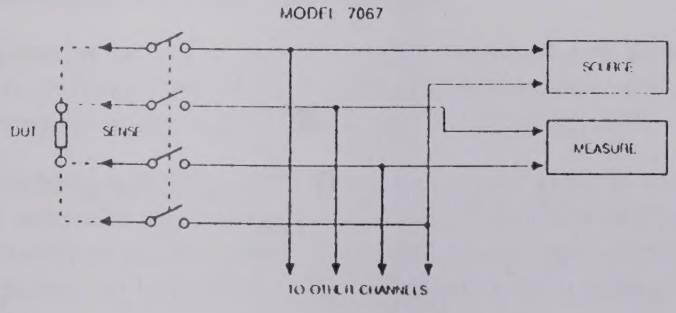
Maintenance should be performed by qualified service personnel. Before performing any maintenance, disconnect the line cord and all test cables.

# SPECIFICATIONS

MODEL 7067 4 WIRE SCANNER CARD

CHANNELS PER CARD: 10.
CONTACT CONFIGURATION: 4-Pole Form A, common shield connection.
CONNECTOR TYPE: Quick disconnect screw terminal, #18 AWG maximum wire size.
RELAY DRIVE CURRENT: 35mA per channel typical.
SENSE LINES:
  SIGNAL LEVEL: 150V, 100mA, 2VA max (resistive loads only)
  CONTACT RESISTANCE: $<0.5\Omega$ initial, $2\Omega$ to rated life
  CONTACT POTENTIAL: $<1\mu V$ per contact pair with copper leads (<5 minutes after actuation).
SOURCE LINES:
  SIGNAL LEVEL: 150V, 350mA, 10VA max (resistive loads only)
  CONTACT RESISTANCE: $<0.2\Omega$ initial, $2\Omega$ to rated life
  CONTACT POTENTIAL: $<50\mu V$ per contact pair
CONTACT LIFE: $>10^6$ closures at maximum signal level, $>10^8$ at dry circuit.
WARM UP: 1 hour for thermal stability.
ACTUATION TIME: <2ms, exclusive of mainframe.
CHANNEL ISOLATION: $>10^9\Omega$, <10pF.
INPUT ISOLATION, DIFFERENTIAL: $>10^9\Omega$, <50pF.
COMMON MODE VOLTAGE: <150V peak.

GENERAL
OPERATING ENVIRONMENT: 0° to 50°C, up to 35°C at 70% RH.
STORAGE ENVIRONMENT: −25°C to 65°C.
DIMENSIONS, WEIGHT: 32mm high × 114mm wide × 272mm long (1¼" × 4½" × 10¾"). Net weight 0.4Kg (14oz.).




Specifications subject to change without notice.

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# SECTION 1
# GENERAL INFORMATION

## 1.1 INTRODUCTION

### 1.1.1 Product Description

The Model 7067 4-wire Scanner Card has 10 channels of four-pole, single-throw (4PST), normally open (NO) relays. Features of the scanner card include:

- Low thermal voltage offset error (contact potential).
- Quick disconnect terminal blocks for each channel.
- Long life 150V reed relays.
- 100 channels per second in Model 705 or 706 scanner.

### 1.1.2 Manual Overview

This instruction manual is organized in the following manner:

- Section 1 General Information—Includes a product description and an overview of the manual, information on warranty, manual addenda, safety symbols and terms, unpacking and inspection, and specifications.
- Section 2 Operation—Includes safety information, wiring and installation, operating instructions, and applications.
- Section 3 Performance Verification—Provides the procedures to check proper operation of the card.
- Section 4 Replaceable Parts—Includes a parts list, a component layout, and a schematic diagram.

## 1.2 WARRANTY INFORMATION

Warranty information is stated on the inside front cover of this manual. If there is a need for service, contact the Keithley representative or authorized repair facility in your area. Check the back cover for addresses. The service form supplied at the end of the manual should be used to provide the service facility with information concerning any difficulty.

## 1.3 MANUAL ADDENDA

Product improvements or changes to this manual will be explained on an addendum included with the manual. It is recommended that this information be incorporated immediately into the appropriate places in the manual.

If an additional instruction manual is required, order the manual package (Keithley Part Number 7067-901-00). The manual package includes an instruction manual and all pertinent addenda.

## 1.4 SAFETY SYMBOLS AND TERMS

The **WARNING** used in this manual explains dangers that could result in personal injury or death.

The **CAUTION** used in this manual explains hazards that could damage the instrument.

## 1.5 UNPACKING AND INSPECTION

The Model 7067 was inspected both electrically and mechanically before shipment. Upon receiving the Model 7067, unpack all items from the shipping carton and check for any obvious damage that may have occurred during transit. Report any damage to the shipping agent. Retain and use the original packaging materials in case reshipment is necessary. The following items are shipped with every Model 7067:

## 1.6 SPECIFICATIONS

Detailed specifications of the Model 7067 precede the Table of Contents of this manual.

# SECTION 2
# OPERATION

## 2.1 INTRODUCTION

This section contains safety information, wiring instructions, an installation procedure of the card, operating instructions, and some applications for the card.

## 2.2 SAFETY PRECAUTIONS

**WARNING**

**User supplied lethal voltages may be present on the PC board or the connectors. Turn off all power and discharge stored energy in external circuitry before making or breaking connections.**

1. Do not exceed the Model 7067's maximum voltages of ±150V peak terminal to terminal and ±150V peak terminal to chassis.
2. Make sure the scanner mainframe is grounded through an earth grounded receptacle before operation.
3. Inspect all test lead connections for wear and defects such as cracks and exposed wires.
4. The Model 7067 is not intended to directly switch AC mains. Switching low power AC signals is explained in paragraph 2.5.2.

## 2.3 WIRING

Each channel on the Model 7067 has a pair of double-pole single-throw (DPST), normally open (NO) relays. Since each pair of relays is energized simultaneously, this yields a single four-pole single-throw (4PST), normally open (NO) relay per channel.

### 2.3.1 Wiring Notes

1. Because of the high impedance of the board, take special care when handling and using to prevent degradation of performance. Handle the board by the edges only and keep it free of body oils, dirt, and contaminants. To clean the board, use an uncontaminated solvent such as Freon® TMS or TE and clean cotton swabs or a soft brush. After the solvent has been applied and is still liquid, blow-dry the board with dry nitrogen gas.
2. Shield Connection - Use shielded cables when switching above 50V or high current. Connect the cable shield between the board's SHIELD terminal and circuit LO of the external system to reduce coil to contact coupling. The cable rating should exceed the maximum signal levels of the Model 7067 specifications.
3. RFI Filtering - Radio frequency interference on inputs or outputs may cause problems with low level measurements or coupling to other channels. In addition to shielded wiring, RFI filtering, such as chokes and bypass capacitors, may be required on these lines to operate the cards to their full specifications.

### 2.3.2 4PST Configuration

To use the Model 7067 in the four-pole, single-throw (4PST) configuration, connect the devices under test to the card channels, and the source and measuring instruments to the card output. See Figure 2-1.

When making 4-wire resistance measurements, connect the HI leads together and the LO leads together at the device. This is shown in Figure 2-2.

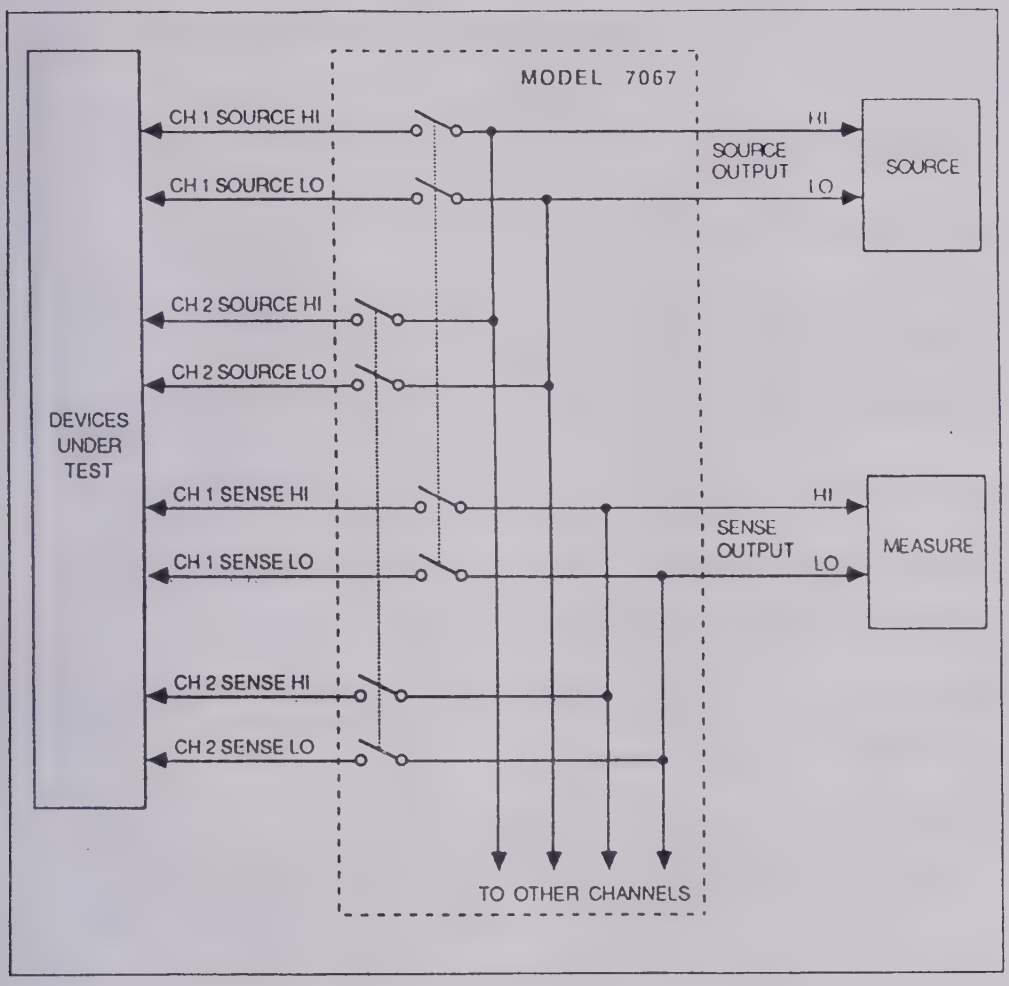


**Figure 2-1. 4PST Configuration**

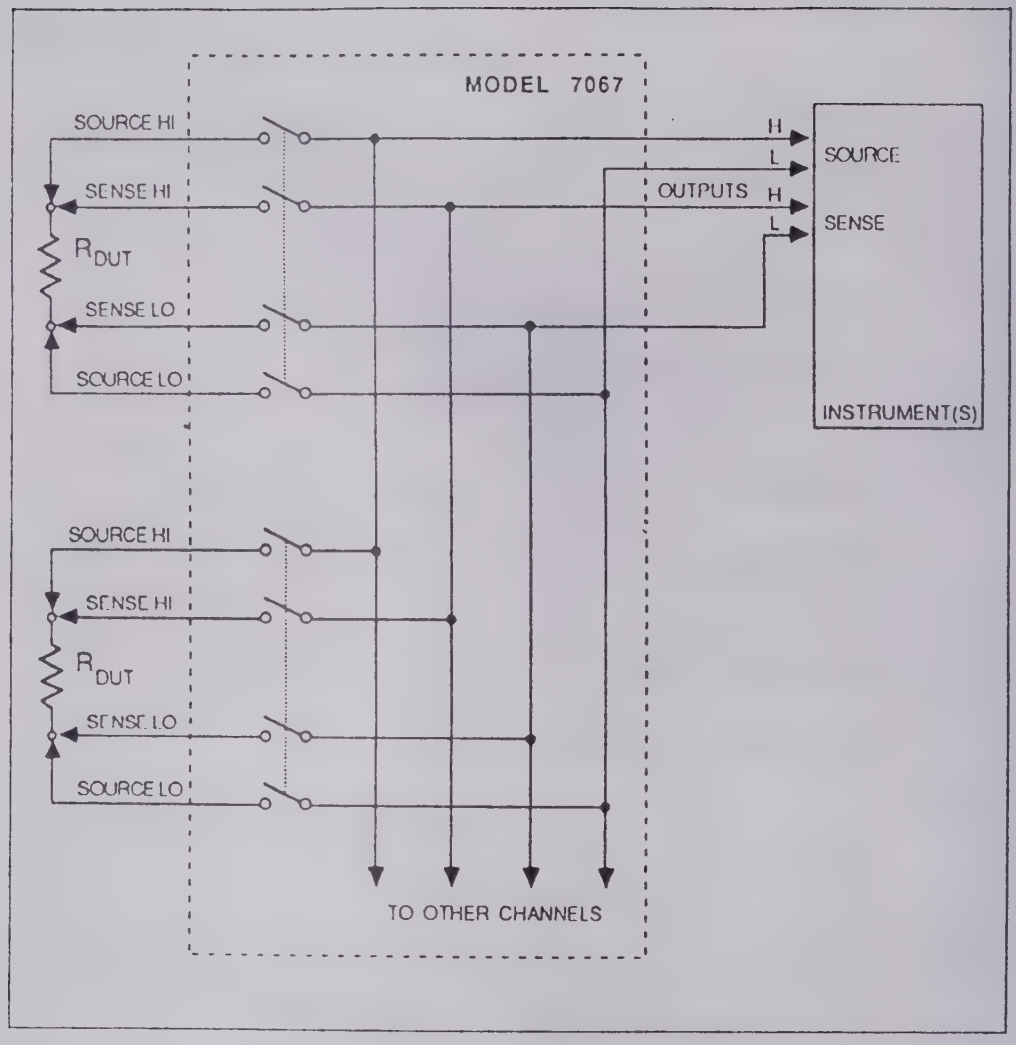


Figure 2-2. 4-Wire Resistance Measurements

### 2.3.3 Terminal Block Connections

Perform the following procedure to wire circuitry to the quick disconnect terminal blocks of the Model 7067.

1. Remove the terminal block from the scanner card by pulling it off the PC board.
2. Using an insulated screwdriver, connect the circuitry to the terminal block as shown in Figure 2-3. (Note that connections for channels 6-10 are a mirror image of channels 1-5). The screw terminals accept up to #18 AWG wire. To ensure thermal offsets of less than 1μV, pure copper wires should be used in the sense connections.
3. Reinstall the terminal block on the card. Make sure the pins on the card are properly mated to the terminal block.
4. Repeat steps 1 through 3 for additional terminal blocks.
5. Remove one screw from the cable clamp of the scanner card and route the terminal block wires as shown in Figure 2-3.
6. Reassemble and tighten the cable clamp. The clamp serves as a strain relief for the terminal block wires.

**NOTE**

To order extra terminal blocks, order Keithley part number CS-570-4 (4-pin) or CS-570-5 (5-pin). See paragraph 4.3 for ordering information.

## 2.4 INSTALLATION AND REMOVAL

Once the card is wired, insert it card edge first into the scanner mainframe by aligning it with the grooves in the appropriate slot. Make sure it is properly seated into the mainframe connector. Push the locking tabs forward to the center of the card to lock it in.

To remove a card, first turn off the mainframe and all other equipment connected to the card. Unfasten the locking tabs on the card by pulling the tabs outward. Grasp the end of the card and carefully pull it out of the mainframe.

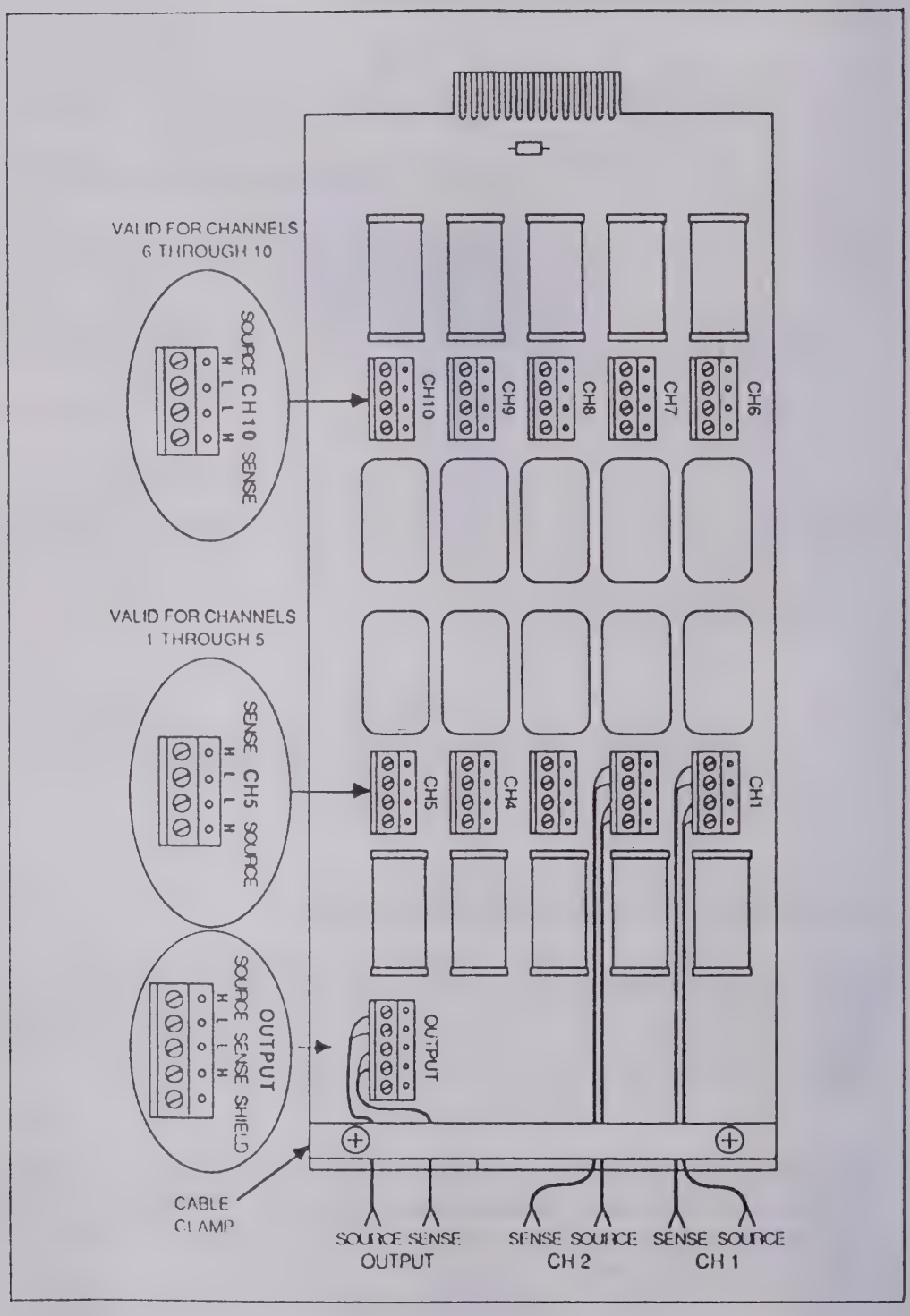


**Figure 2-3. Terminal Blocks and Wire Routing**

## 2.5 OPERATION

### 2.5.1 Scanner Control of the Channels

Since the Model 7067 is a 10-channel card, set the scanner to the 2-pole mode when using the Model 7067 by itself or when intermixing with other 10-channel cards (such as Models 7056, 7058, 7059, and 7066). In the 2-pole mode, each scanner channel controls one channel on one 10-channel card.

As an example, consider the combination of a Model 7067 and Model 7059. Table 2-1 shows the scanner and card channel assignments for a master scanner.

**Table 2-1. Example Channel Assignments in 2-Pole Mode**

| Card 1 - Model 7067 10 channels | | Card 2 - Model 7059 10 channels | |
|---|---|---|---|
| Scanner Ch. No. | 7067 Ch. No. | Scanner Ch. No. | 7059 Ch. No. |
| 001 | 1 | 011 | 1 |
| 002 | 2 | 012 | 2 |
| 003 | 3 | 013 | 3 |
| 004 | 4 | 014 | 4 |
| 005 | 5 | 015 | 5 |
| 006 | 6 | 016 | 6 |
| 007 | 7 | 017 | 7 |
| 008 | 8 | 018 | 8 |
| 009 | 9 | 019 | 9 |
| 010 | 10 | 020 | 10 |

The Model 7067 can be mixed with cards other than 10-channel cards, but there are complications when changing the pole mode to support

a mix of card types. When using a Model 7067 in combination with a 20-channel card, such as the Model 7064, set the scanner to 1-pole mode. In this mode, each scanner channel controls one channel on one 20-channel card. The effect on the Model 7067 channel assignments is shown in Table 2-2.

**NOTE**

In the 1-pole scanner mode, close one channel at a time when using the Model 7067. Otherwise, other channels are closed on the card and show up on the mainframe display. For example, close channels 2 and 5, channels 1 and 6 also close.

## Table 2-2. Example Channel Assignments in 1-Pole Mode

| Card 1 - Model 7067 10 channels | | Card 2 - Model 7064 20 channels | |
|---|---|---|---|
| Scanner Ch. No. | 7067 Ch. No. | Scanner Ch. No. | 7064 Ch. No. |
| 001 | 1 | 021 | 1 |
| 002 | 1 | 022 | 2 |
| 003 | 2 | 023 | 3 |
| 004 | 2 | 024 | 4 |
| 005 | 3 | 025 | 5 |
| 006 | 3 | 026 | 6 |
| 007 | 4 | 027 | 7 |
| 008 | 4 | 028 | 8 |
| 009 | 5 | 029 | 9 |
| 010 | 5 | 030 | 10 |
| 011 | 6 | 031 | 11 |
| 012 | 6 | 032 | 12 |
| 013 | 7 | 033 | 13 |
| 014 | 7 | 034 | 14 |
| 015 | 8 | 035 | 15 |
| 016 | 8 | 036 | 16 |
| 017 | 9 | 037 | 17 |
| 018 | 9 | 038 | 18 |
| 019 | 10 | 039 | 19 |
| 020 | 10 | 040 | 20 |

Next, consider a mix of a 10-channel card (Model 7067), a 20-channel card (Model 7064), and a matrix card (Model 7052) in a Model 706 scanner mainframe. Since a matrix card is present, the scanner is set to matrix (0-pole) mode. The scanner crosspoints and card channel assignments for a master scanner are shown in Table 2-3.

When using 20-channel cards in matrix mode, two crosspoints must be closed for each of the card channels.

**Table 2-3. Example Channel Assignments in Matrix (0-Pole) Mode**

| Card 1 - Model 7067 10 channels | | Card 2 - Model 7064 20 channels | |
|---|---|---|---|
| 706 Crosspoint | 7067 Ch. No. | 706 Crosspoints | 7064 Ch. No. |
| 001,1 | 1 | 006,1 007,3 | 1 |
| 002,1 | 2 | 006,1 006,3 | 2 |
| 003,1 | 3 | 007,1 007,3 | 3 |
| 004,1 | 4 | 007,1 006,3 | 4 |
| 005,1 | 5 | 008,1 007,3 | 5 |
| 001,2 | 6 | 008,1 006,3 | 6 |
| 002,2 | 7 | 009,1 007,3 | 7 |
| 003,2 | 8 | 009,1 006,3 | 8 |
| 004,2 | 9 | 010,1 007,3 | 9 |
| 005,2 | 10 | 010,1 006,3 | 10 |
| | | 006,2 007,3 | 11 |
| | | 006,2 006,3 | 12 |
| | | 007,2 007,3 | 13 |
| | | 007,2 006,3 | 14 |
| | | 008,2 007,3 | 15 |
| | | 008,2 006,3 | 16 |
| | | 009,2 007,3 | 17 |
| | | 009,2 006,3 | 18 |
| | | 010,2 007,3 | 19 |
| | | 010,2 006,3 | 20 |

In general, the rules for choosing different scanner pole modes are:

matrix (0-pole) — If a matrix card is present.
1-pole — If a 20-channel card is present, but no matrix card.
2-pole — If a 10-channel card is present, but no 20-channel or matrix cards.
4-pole — If 4-pole switching is desired with two 2-pole, 10-channel cards.

Since the Model 7067 is a 4-pole card, if two cards are used in the 4-pole scanner mode, the result is ten channels of 8-pole operation.

Tables 2-4 through 2-7 list the scanner channels that control Model 7067 channels for all scanner pole configurations.

## Table 2-4. Scanner Control of Model 7067 4-Pole Mode

| Card No. | Scanner Channel No. | 7067 Channel No. | Scanner |
|---|---|---|---|
| 1 | 01-10 | 1-10 | 705, 706 |
| 2 | 01-10 | 1-10 | 705, 706 |
| 3 | 11-20 | 1-10 | 706 |
| 4 | 11-20 | 1-10 | 706 |
| 5 | 21-30 | 1-10 | 706 |
| 6 | 21-30 | 1-10 | 706 |
| 7 | 31-40 | 1-10 | 706 |
| 8 | 31-40 | 1-10 | 706 |
| 9 | 41-50 | 1-10 | 706 |
| 10 | 41-50 | 1-10 | 706 |

## Table 2-5. Scanner Control of Model 7067 2-Pole Mode

| Card No. | Scanner Channel No. | 7067 Channel No. | Scanner |
|---|---|---|---|
| 1 | 01-10 | 1-10 | 705, 706 |
| 2 | 11-20 | 1-10 | 705, 706 |
| 3 | 21-30 | 1-10 | 706 |
| 4 | 31-40 | 1-10 | 706 |
| 5 | 41-50 | 1-10 | 706 |
| 6 | 51-60 | 1-10 | 706. |
| 7 | 61-70 | 1-10 | 706 |
| 8 | 71-80 | 1-10 | 706 |
| 9 | 81-90 | 1-10 | 706 |
| 10 | 91-100 | 1-10 | 706 |

## Table 2-6. Scanner Control of Model 7067 1-Pole Mode

| Card 1 | Card 2 | Card 3 | Card 4 | Card 5 | |
|---|---|---|---|---|---|
| Scanner Ch. No. | Scanner Ch. No. | Scanner Ch. No. | Scanner Ch. No. | Scanner Ch. No. | 7067 Ch. No. |
| 01, 02 | 21, 22 | 41, 42 | 61, 62 | 81, 82 | 1 |
| 03, 04 | 23, 24 | 43, 44 | 63, 64 | 83, 84 | 2 |
| 05, 06 | 25, 26 | 45, 46 | 65, 66 | 85, 86 | 3 |
| 07, 08 | 27, 28 | 47, 48 | 67, 68 | 87, 88 | 4 |
| 09, 10 | 29, 30 | 49, 50 | 69, 70 | 89, 90 | 5 |
| 11, 12 | 31, 32 | 51, 52 | 71, 72 | 91, 92 | 6 |
| 13, 14 | 33, 34 | 53, 54 | 73, 74 | 93, 94 | 7 |
| 15, 16 | 35, 36 | 55, 56 | 75, 76 | 95, 96 | 8 |
| 17, 18 | 37, 38 | 57, 58 | 77, 78 | 97, 98 | 9 |
| 19, 20 | 39, 40 | 59, 60 | 79, 80 | 99, 100 | 10 |
| 705, 706 | 705, 706 | 706 | 706 | 706 | |

| Card 6 | Card 7 | Card 8 | Card 9 | Card 10 | |
|---|---|---|---|---|---|
| Scanner Ch. No. | Scanner Ch. No. | Scanner Ch. No. | Scanner Ch. No. | Scanner Ch. No. | 7067 Ch. No. |
| 101, 102 | 121, 122 | 141, 142 | 161, 162 | 181, 182 | 1 |
| 103, 104 | 123, 124 | 143, 144 | 163, 164 | 183, 184 | 2 |
| 105, 106 | 125, 126 | 145, 146 | 165, 166 | 185, 186 | 3 |
| 107, 108 | 127, 128 | 147, 148 | 167, 168 | 187, 188 | 4 |
| 109, 110 | 129, 130 | 149, 150 | 169, 170 | 189, 190 | 5 |
| 111, 112 | 131, 132 | 151, 152 | 171, 172 | 191, 192 | 6 |
| 113, 114 | 133, 134 | 153, 154 | 173, 174 | 193, 194 | 7 |
| 115, 116 | 135, 136 | 155, 156 | 175, 176 | 195, 196 | 8 |
| 117, 118 | 137, 138 | 157, 158 | 177, 178 | 197, 198 | 9 |
| 119, 120 | 139, 140 | 159, 160 | 179, 180 | 199, 200 | 10 |
| 706 | 706 | 706 | 706 | 706 | |

## Table 2-7. Scanner Control of Model 7067 Matrix (0-Pole) Mode

| Card 1 | Card 2 | Card 3 | Card 4 | Card 5 | |
|---|---|---|---|---|---|
| Scanner Ch. No. | Scanner Ch. No. | Scanner Ch. No. | Scanner Ch. No. | Scanner Ch. No. | 7067 Ch. No. |
| 01, 1 | 06, 1 | 11, 1 | 16, 1 | 21, 1 | 1 |
| 02, 1 | 07, 1 | 12, 1 | 17, 1 | 22, 1 | 2 |
| 03, 1 | 08, 1 | 13, 1 | 18, 1 | 23, 1 | 3 |
| 04, 1 | 09, 1 | 14, 1 | 19, 1 | 24, 1 | 4 |
| 05, 1 | 10, 1 | 15, 1 | 20, 1 | 25, 1 | 5 |
| 01, 2 | 06, 2 | 11, 2 | 16, 2 | 21, 2 | 6 |
| 02, 2 | 07, 2 | 12, 2 | 17, 2 | 22, 2 | 7 |
| 03, 2 | 08, 2 | 13, 2 | 18, 2 | 23, 2 | 8 |
| 04, 2 | 09, 2 | 14, 2 | 19, 2 | 24, 2 | 9 |
| 05, 2 | 10, 2 | 15, 2 | 20, 2 | 25, 2 | 10 |
| 705, 706 | 705, 706 | 706 | 706 | 706 | |

| Card 6 | Card 7 | Card 8 | Card 9 | Card 10 | |
|---|---|---|---|---|---|
| Scanner Ch. No. | Scanner Ch. No. | Scanner Ch. No. | Scanner Ch. No. | Scanner Ch. No. | 7067 Ch. No. |
| 26, 1 | 31, 1 | 36, 1 | 41, 1 | 46, 1 | 1 |
| 27, 1 | 32, 1 | 37, 1 | 42, 1 | 47, 1 | 2 |
| 28, 1 | 33, 1 | 38, 1 | 43, 1 | 48, 1 | 3 |
| 29, 1 | 34, 1 | 39, 1 | 44, 1 | 49, 1 | 4 |
| 30, 1 | 35, 1 | 40, 1 | 45, 1 | 50, 1 | 5 |
| 26, 2 | 31, 2 | 36, 2 | 41, 2 | 46, 2 | 6 |
| 27, 2 | 32, 2 | 37, 2 | 42, 2 | 47, 2 | 7 |
| 28, 2 | 33, 2 | 38, 2 | 43, 2 | 48, 2 | 8 |
| 29, 2 | 34, 2 | 39, 2 | 44, 2 | 49, 2 | 9 |
| 30, 2 | 35, 2 | 40, 2 | 45, 2 | 50, 2 | 10 |
| 706 | 706 | 706 | 706 | 706 | |

## 2.5.2 Operation Notes

1. To ensure reliable relay performance, do not energize more than seven channels at the same time when using the Model 705 Scanner. In the Model 706, the number of channels that can be energized simultaneously depends on factors such as temperature and ventilation. Refer to Table 2-8. The quantities given in this table assume that only Model 7067 cards are installed. If relays from other cards are energized at the same time, their drive currents will reduce these quantities.

### Table 2-8. Maximum Number of Simultaneous Channel Closures of Model 7067 in Model 706 Scanner

| Temp. | Using Louvers and Letting 706 Stand Free | Using Louvers and "1" Space Between Scanners in Rack | 706 Closed in Rack | Max. No. of Channels in the 706 |
|---|---|---|---|---|
| 23°C | 100 | 100 | 100 | 100 |
| 50°C | 94 | 65 | 37 | 100 |

2. Power Limits - To prevent overheating or damage to the relay contacts, never exceed the signal level specifications of the relay. Maximum switched voltage and current levels are 150V, 350mA on the source lines and 150V, 100mA on the sense lines. The maximum carry current (cold switching) is 1A on the source lines. The power limits are 10VA for source and 2VA for sense, both with resistive loads only.
3. DC and AC Switching - The Model 7067 can switch DC and low power AC with the following restrictions:
   A. Do not exceed the signal level specifications of the card.
   B. The typical frequency bandwidth for low power AC is up to 1MHz with the RC models given in the card isolation specifications. Better frequency response is obtained by connecting the cards SHIELD terminal to common of the source instrument.

C. To prevent damage if an incorrect combination of relays is closed, ensure the source is current limited with a crowbar, current limit, or fused circuit. Use a fuse to limit source line current or sense line current if the source is not limited.

D. If voltage transients are present, line filtering must be used to limit the transients and RF noise to the card specifications. Figure 2-4 shows a protection circuit between the voltage source and the source relays. Similar protection can be used between the device under test and the sense relays when testing an active device (e.g. instrumentation amp).

4. Switching Speed - Relay actuation time is 2msec maximum (typically 0.6msec actuation, 0.25msec release), plus the mainframe programming time. Maximum relay switching rate at low signal levels is 100 cycles per second (10msec). This is the maximum rate of the scanner mainframe. For extended relay life, use low power or cold switching (turn on sources after channel is closed).

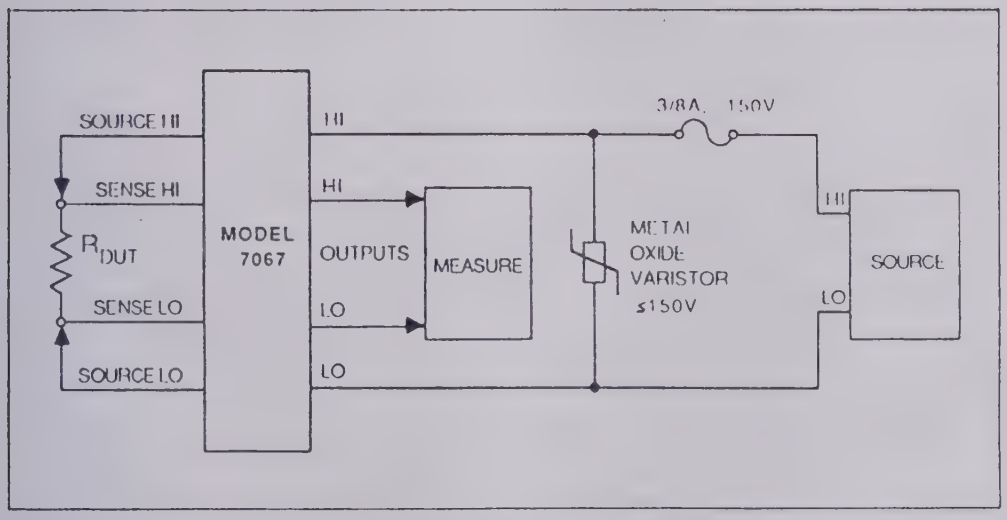


**Figure 2-4. Clamping Transients**

## 2.6 APPLICATIONS

The Model 7067 can be used in a variety of applications requiring 4-wire switching. Since the card is labeled for resistance measurement applications and the specifications for source and sense lines are different, proper system configuration is important.

## 2.6.1 Non-resistance Measurements

Figure 2-5 shows sample testing of a differential input amplifier block (with pin programmable or digitally programmable gain settings). This setup is useful for comparing the actual gain of an amplifier to its predicted gain over a range of input voltages or operating temperatures.

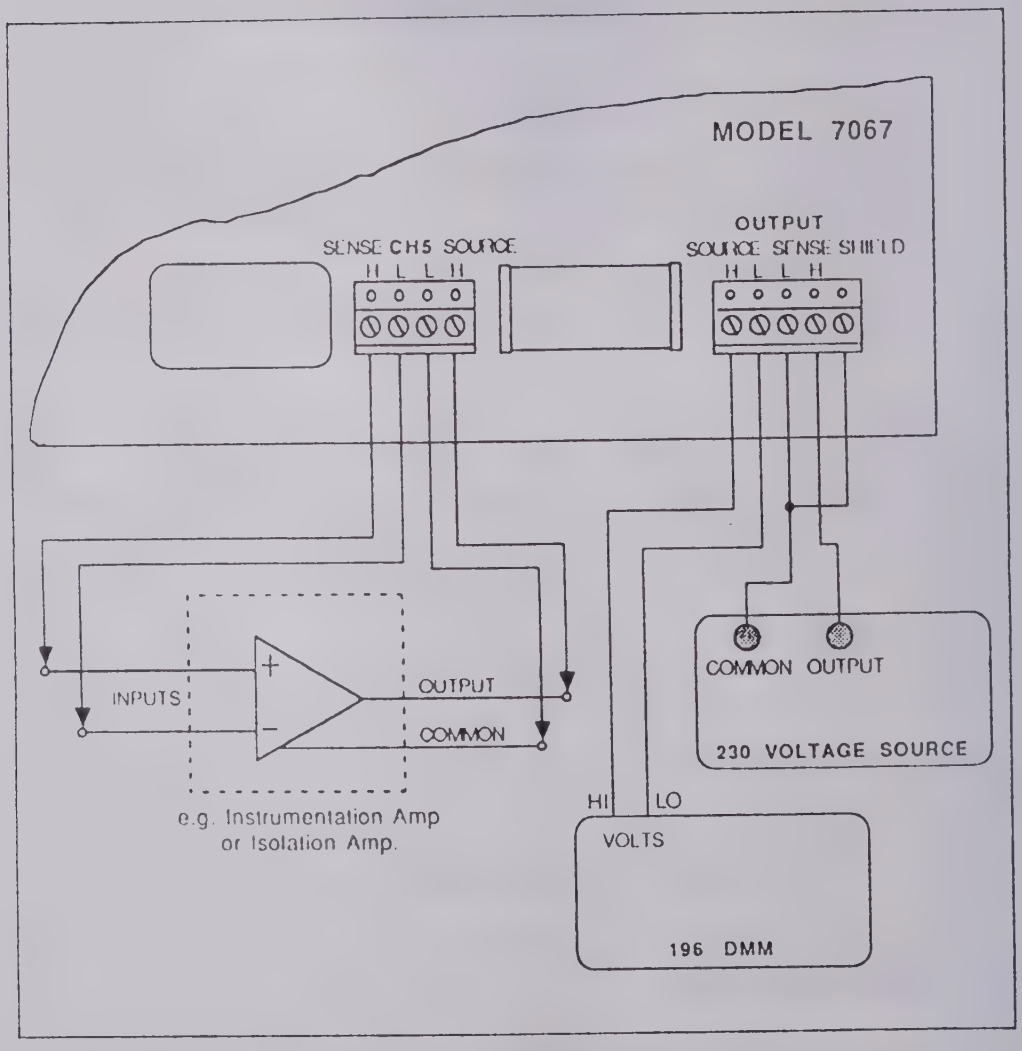


**Figure 2-5. Measuring Gain of Differential Amp Block**

In this application, the sense (measure) terminals are used for the input since they have better DC offsets. By using a Model 230 voltage source, you can vary the input voltage to test linearity. One channel on the Model 7067 should be shorted (sense to source) to directly read the Model 230 output for reference.

When a load is connected to a voltage source like the Model 230, there is an IR lead drop between the load and the Model 230. If the IR drop is too large to be tolerated, the Model 230 can be configured for remote sensing as shown in Figure 2-6. Remote sensing compensates for the IR lead drop by maintaining regulation at the load instead of the Model 230 output terminals. This compensation is up to 0.5V per output lead with a maximum of 5Ω per sense lead.

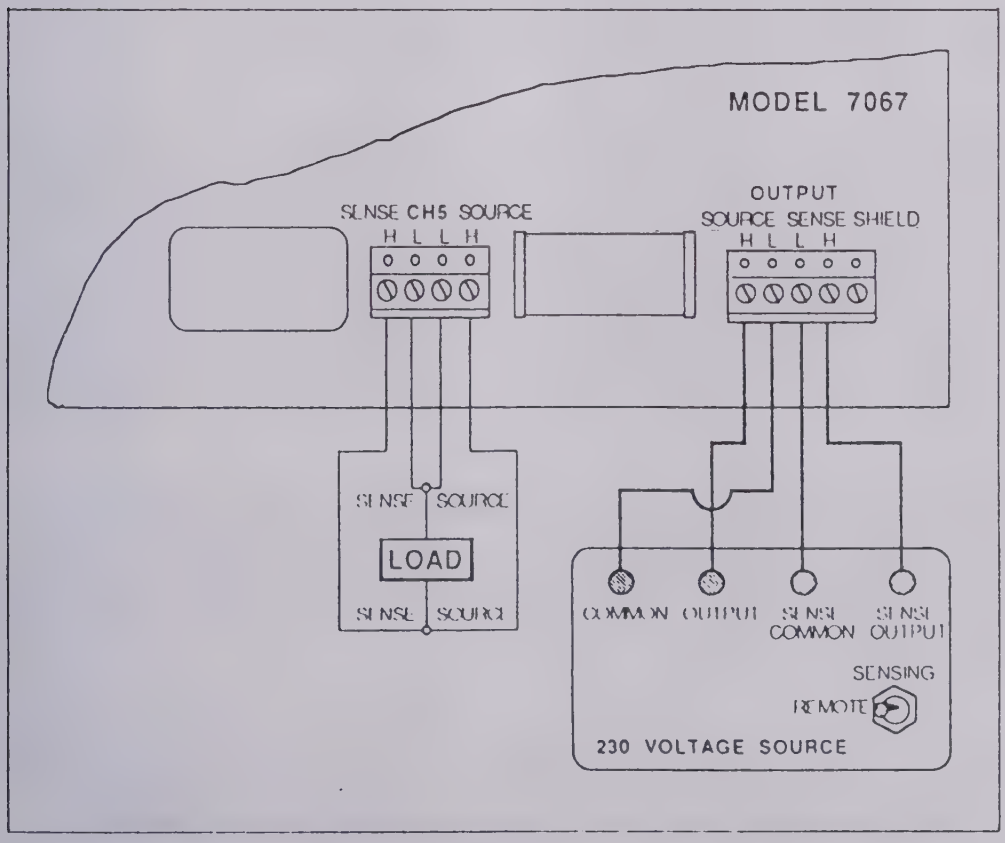


**Figure 2-6. Remote Voltage Sensing**

When using remote sensing, the Sense Output and Sense Common terminals on the Model 230 must be connected to the output and common terminals at the load.

**CAUTION**

**Be sure to connect the sense terminals of the Model 230 to the load with the proper polarity. Improper polarity could possibly damage the instrument.**

## 2.6.2 Resistance Measurements

In the 2-terminal method of measuring resistance, problems occur when measuring low values (less than 1000Ω) and small changes in resistance. If the voltage drop across the test leads and connectors is a substantial percentage of the voltage across the device under test, measurement accuracy suffers.

Because of these problems, low resistance measurements are commonly made with the 4-terminal method shown in Figure 2-7. Source leads supply a known current to the device and sense leads read the voltage drop across the device. If the voltmeter has a high input resistance, the current through the sense leads will be negligible, and the voltage read will be essentially the same as the voltage across the device. The resistance is calculated by dividing the voltage drop by the applied current.

Other factors affect measurement accuracy of low resistances. Thermal EMFs can add an extraneous DC offset voltage to the measured voltage. If this offset remains steady, it can be cancelled by applying positive and negative currents of the same magnitude, or by using a DMM with a zero correction feature.

**NOTE**

Refer to Application Notes #301, "Automating Low Resistance Measurements", and #700, "Switching in Multipoint Testing", for more details about 4-terminal resistance measurements.

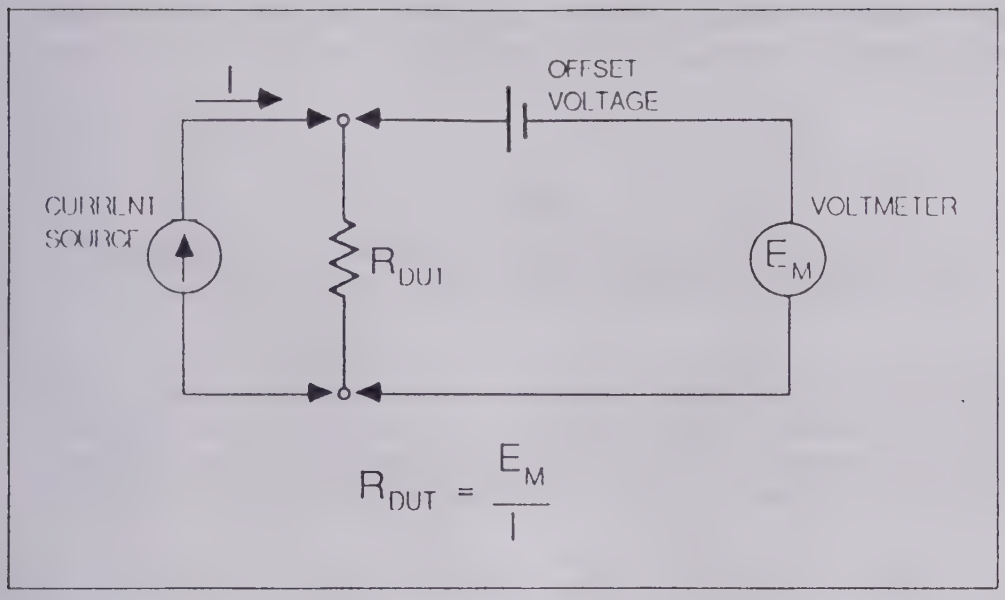


**Figure 2-7. 4-Terminal Resistance Measurements**

For making 4-terminal measurements, an instrument like the Model 580 Micro-ohmeter or Model 196 System DMM can be used. When measuring resistances in the micro-ohm region, use a separate current source like the Model 220 in combination with a sensitive voltage measuring instrument. Testing of multiple devices requires a scanner card with 4-wire switching and a quality low voltage switch in the sense leads, such as the Model 7067.

The 4-terminal (Kelvin) method of measuring resistance can be used to check the following:

- Low-value resistors.
- Relays and switches.
- Contact resistance of connectors.
- Resistances of cables and PC board traces.

Figure 2-8 shows a Model 580 Micro-ohmmeter measuring low resistances with a Model 7067 switching up to ten devices. (The Model

580 corrects for thermal EMFs by pulsing the source current.) With this one-instrument setup, resistance changes as small as 10$\mu\Omega$ can be detected.

**NOTE**

Keep test lead resistances low for best results. See Tables 2-3 and 2-5 in the Model 580 Operator's Manual.

The 4-terminal method of measuring resistance is also used to check precision transducers like temperature bridges, strain gauges, and linear and rotary transducers. With the two-instrument setup shown in Figure 2-9, resistance changes as small as 1$\mu\Omega$ can be detected.

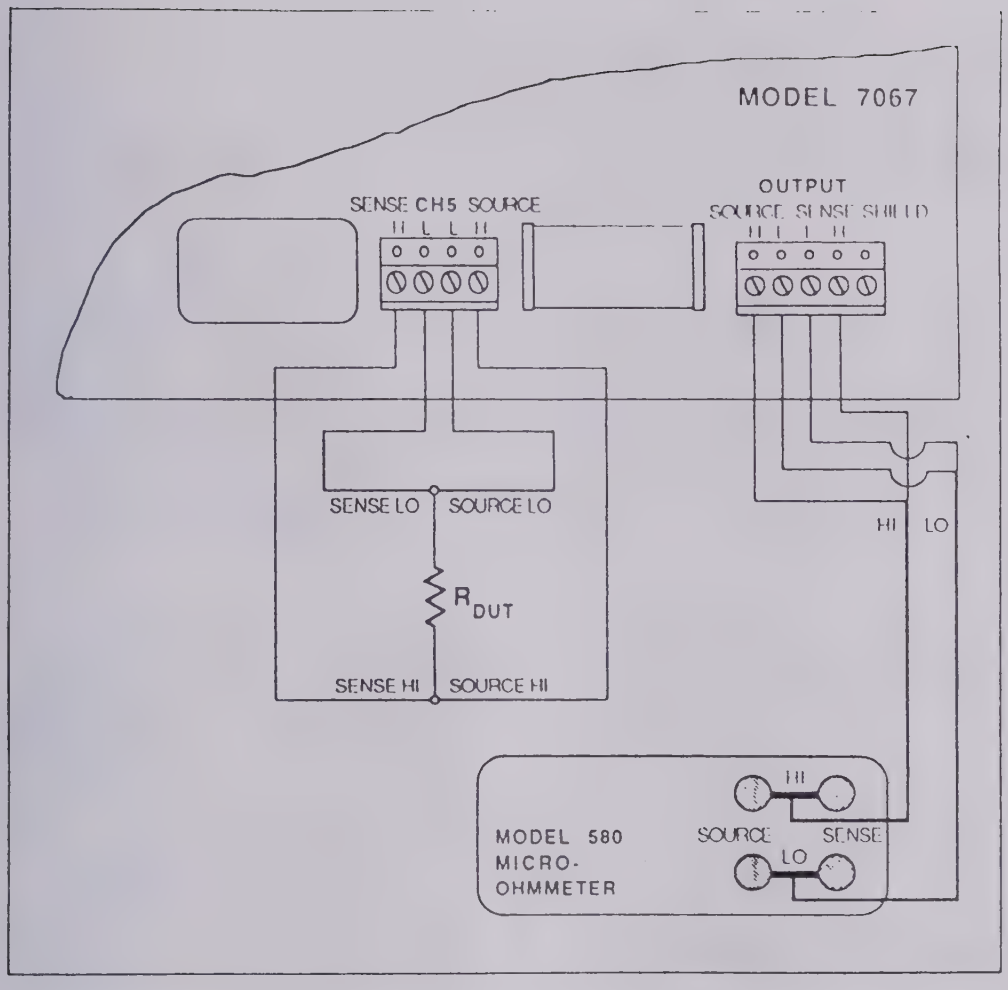


**Figure 2-8. Measuring Resistance With One Instrument**

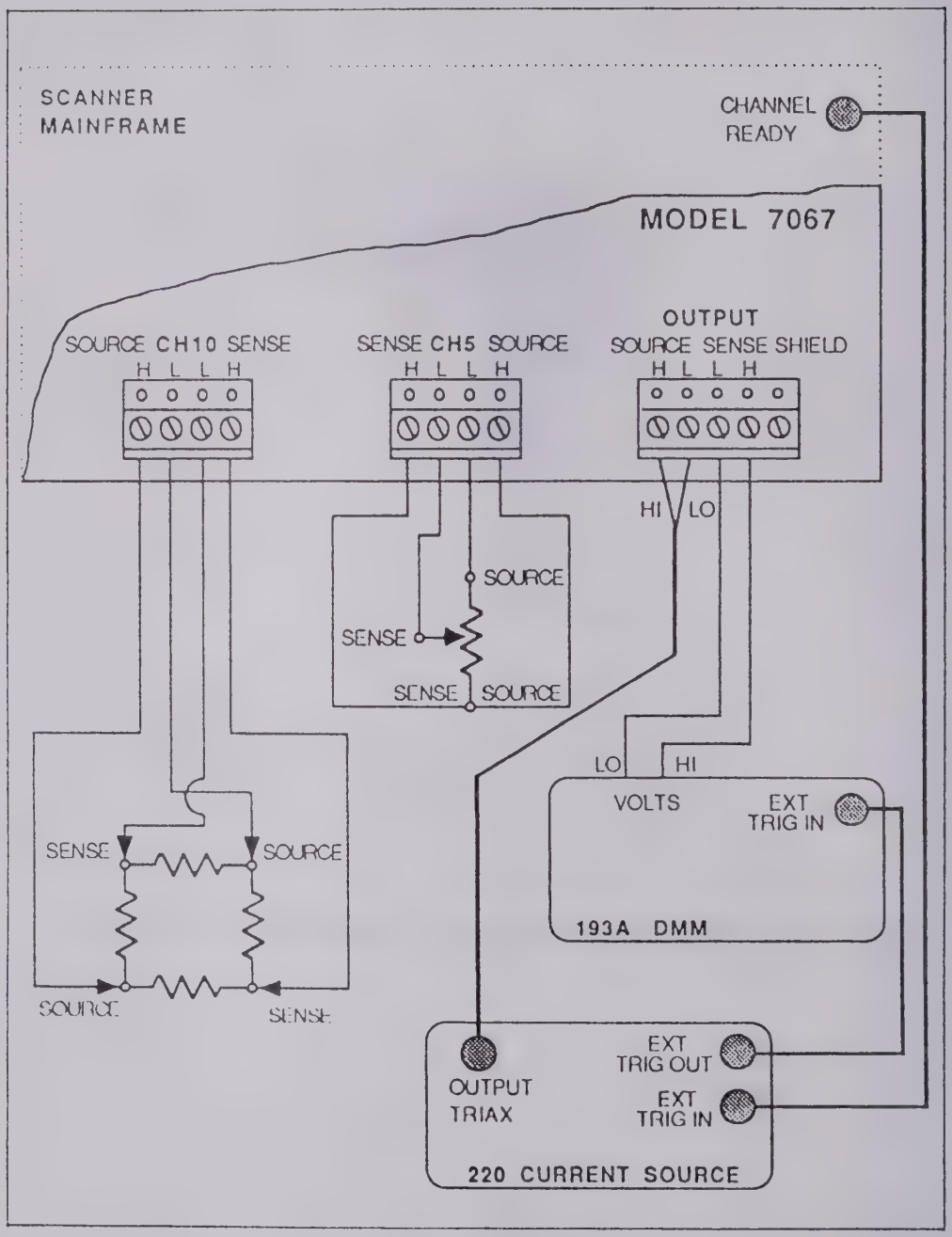


Figure 2-9. Measuring Resistance With Two Instruments

To detect 0.1μΩ changes, use a Model 181 Nanovoltmeter instead of the Model 193A DMM. In addition to greater voltage sensitivity, the Model 181 has lower noise voltage. Also, the Model 181 makes nanovolt measurements in a single conversion rather than the slower process of averaging many microvolt readings as do DMMs.

In the setup of Figure 2-9, a Model 705 scanner triggers a Model 220 current source at channel closure time. (Triggering keeps the power dissipation in the device under test to a minimum.) Then the Model 220 triggers the Model 193A to take a voltage reading. At the next channel closure time, the Model 220 is incremented to its next memory location. This is useful when measuring dissimilar components that require different current levels.

Thermal EMFs are compensated for by closing the channel, zeroing the Model 193A with the Model 220 set to zero current (program zero amps on a low current range, e.g. 1μA, and return to desired range), then turning on the Model 220 output.

# SECTION 3
# SERVICING INFORMATION

## 3.1 INTRODUCTION

This section describes tests for verifying the performance of the Model 7067. The tests include:

- Functionality test—Measuring contact resistance to check for open or shorted relays or bad connections.
- Isolation tests—Three tests measuring leakage currents to check for a dirty board and possibly bad relays.

**WARNING**

**Do not perform the procedures in this section unless you are a qualified service person. Some of the procedures may expose you to potentially lethal voltages (>30V RMS) that could result in personal injury or death if normal safety precautions are not observed.**

Perform these tests at room temperature within the specified operating environment (≤70% RH) of the scanner card.

Recommended maintenance includes inspection of the scanner card and the card edge connector to ensure good electrical contact. The Model 7067 does not require calibration.

## 3.2 RECOMMENDED TEST EQUIPMENT

Table 3-1 lists recommended test equipment for performance verification. Other test equipment may be substituted if specifications equal or exceed those stated. With the Model 7061 Universal Adapter Card, these tests can be performed faster.

Table 3-1. Recommended Test Equipment

| Description | Specification | Mfr. | Model |
|---|---|---|---|
| Scanner Mainframe | — | Keithley | 705 or 706 |
| Extender Card | — | Keithley | 7061 |
| DMM | 300MΩ full scale, 100μΩ resolution | Keithley | 196 |
| Voltage Source | 100VDC | Keithley | 230 |
| Electrometer | $10^{-12}$A | Keithley | 614 or 617 |

**NOTE**

Since the Model 617 electrometer has an internal 100V source, it can be used in the V/I mode instead of the Model 614 electrometer and Model 230 voltage source.

## 3.3 CONTACT RESISTANCE TEST

This test measures the resistance of each relay contact in an opened and closed state. With the Model 7061 adapter card, you can also verify that the channel source and sense relays are energized at the same time.

1. Wire up a channel terminal block and the Output terminal block with two copper wires on each terminal. See Figure 3-1. Use wires long enough to be clamped on the card and exit the scanner if an extender card is not available.
2. Zero the Model 196 with the Kelvin test leads shorted together.
3. If the Model 7061 extender is not available, insert the Model 7067 into the mainframe. Turn on the mainframe and select the channel to be tested.
4. Connect the Kelvin test leads across Output Source High and the channel's Source High. Figure 3-1 shows measurements for channel 5.
5. From the front panel of the mainframe, open and close the channel. Verify that the relay contacts read >300MΩ when open and <2Ω when closed.

6. Zero the Model 196, then connect the Kelvin test leads across Output Source Low and the same channel's Source Low.
7. Take readings for an opened and closed channel. The readings should be $>300M\Omega$ when open and $<2\Omega$ when closed.
8. Repeat steps 2 through 7 for the same channel's sense lines. (Check Output Sense High to Sense High and Output Sense Low to Sense Low.)
9. If the Model 7067 is not on an extender card, turn off the mainframe and remove the scanner card. Move the wired-up channel terminal block to the next channel to be tested.
10. Repeat steps 3 through 9 to check the remaining channels.

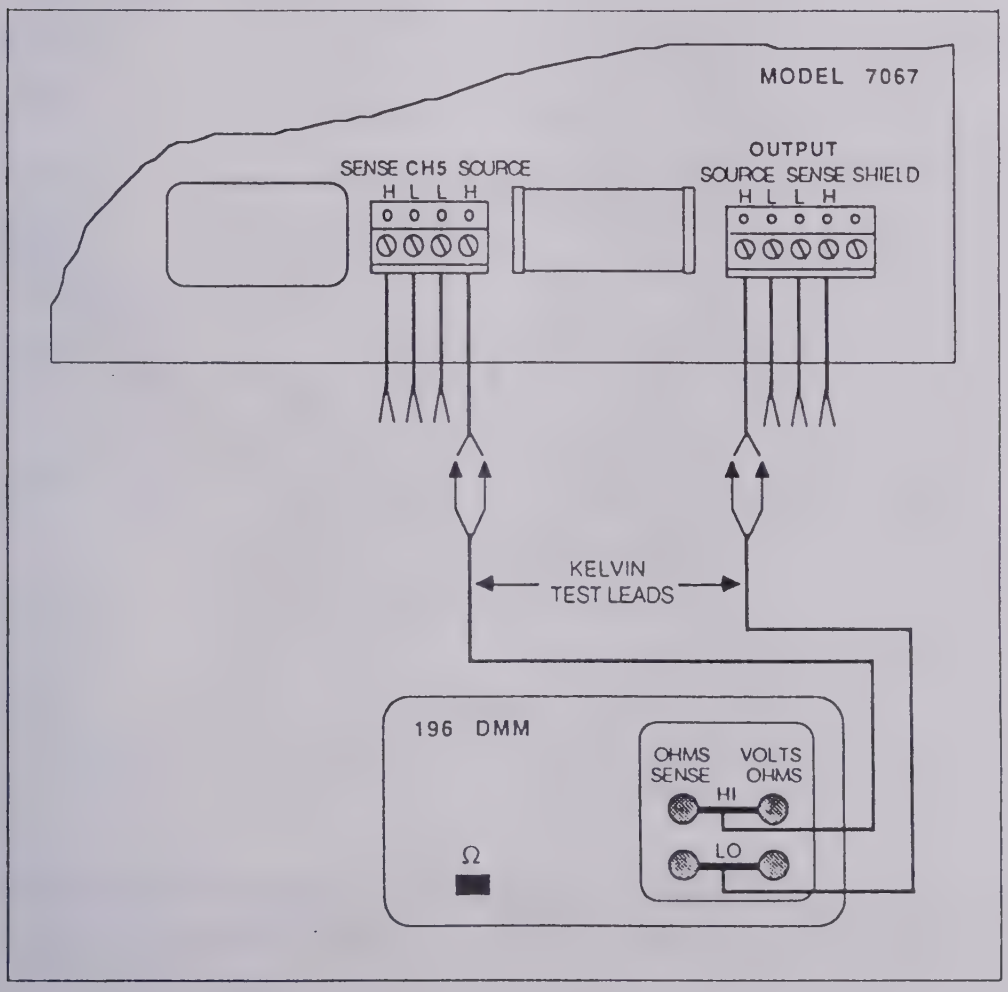


**Figure 3-1. Contact Resistance**

## 3.4 ISOLATION TESTS

The three isolation tests measure leakage currents for calculating leakage resistances on the Model 7067.

### 3.4.1 Channel Isolation

This test measures the leakage current between two channels and channel to output.

1. On the channel terminal blocks, connect jumper wires from Source High to Source Low to Sense High to Sense Low. Do the same on the Output terminal block.
2. Set up the equipment as shown in Figure 3-2 (for channel 5) using the desired channel.
3. Insert the Model 7067 into the scanner and set the mainframe to channel mode, step scan mode, and select the channel under test. Program the selected channel as open and all other channels as closed.
4. Set the electrometer to amps and zero check. Program the Model 230 to output 100V. Take the electrometer out of zero check.
5. The electrometer should read less than $1 \times 10^{-7}$A. (Due to the capacitance of the circuit, the offset current may be high until the circuit capacitance is charged up. Wait until the readings settle out.)
6. Using Ohm's law calculate the channel isolation (the leakage resistance between two channels). For example:

$$R = E/I \quad (100V/10^{-7}A = 10^{9}\Omega).$$

**NOTE**

With the Model 617 electrometer in V/I mode, the resistance is calculated automatically.

7. Put the Model 230 in standby mode and set the electrometer to zero.
8. Repeat steps 3 through 7 for the remaining channels.

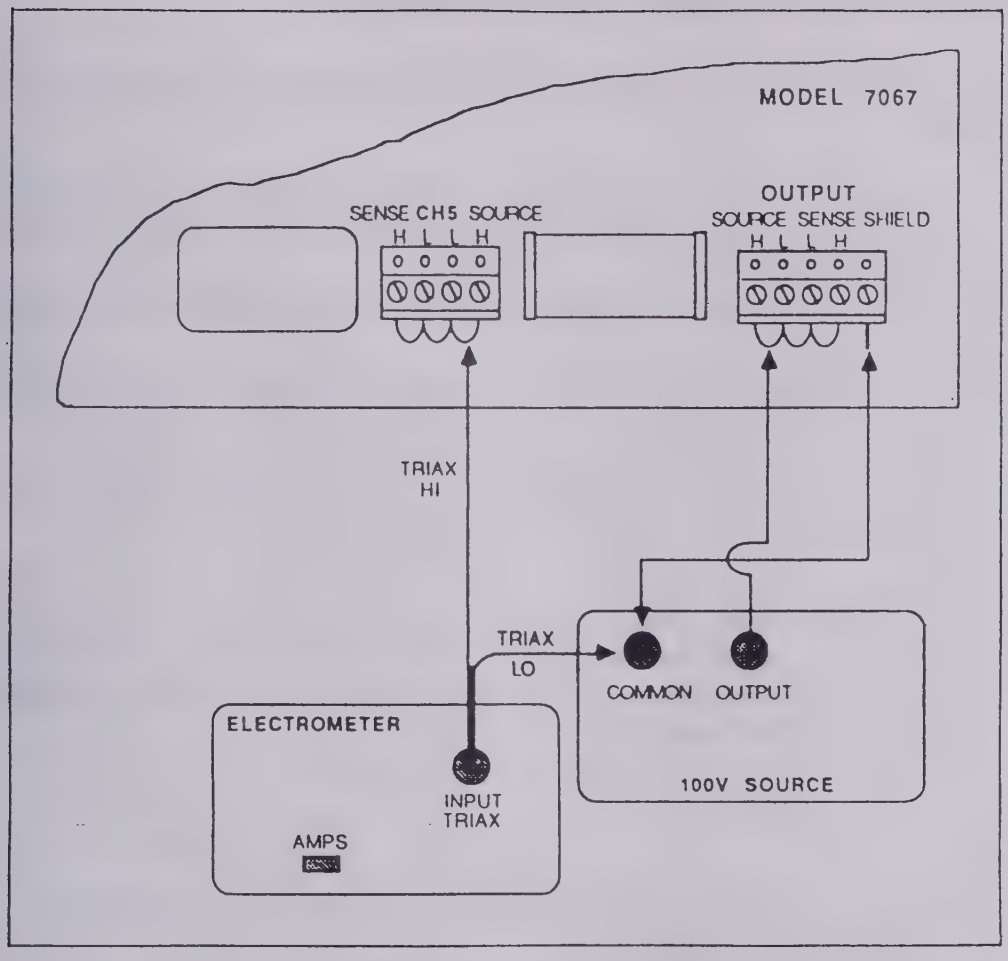


**Figure 3-2. Channel Isolation**

### 3.4.2 Input Isolation, Common Mode

This test measures the leakage current between the signal lines and shield.

1. On the channel terminal blocks, connect a jumper wire between Source High and Source Low, and another jumper between Sense High and Sense Low.
2. Set up the equipment as shown in Figure 3-3 (for channel 5) using the desired channel.
3. Insert the Model 7067 into the scanner and set the mainframe to channel mode, step scan mode, and select the channel under test. Program the selected channel as open and all other channels as closed.
4. Set the electrometer to amps and zero check. Program the Model 230 to output 100V. Take the electrometer out of zero check.
5. The electrometer should read less than 1 x $10^{-7}$A. (Due to the capacitance of the circuit, the offset current may be high until the circuit capacitance is charged up. Wait until the readings settle out.)
6. Using Ohm's law calculate the common mode input isolation (leakage resistance). For example:

$$R = E/I \quad (100V/10^{-7}A = 10^{9}\Omega).$$

**NOTE**

With the Model 617 electrometer in V/I mode, the resistance is calculated automatically.

7. Put the Model 230 in standby mode and set the electrometer to zero.
8. Repeat steps 4 through 7 for the same channel's sense lines.
9. Repeat steps 3 through 8 for the remaining channels.

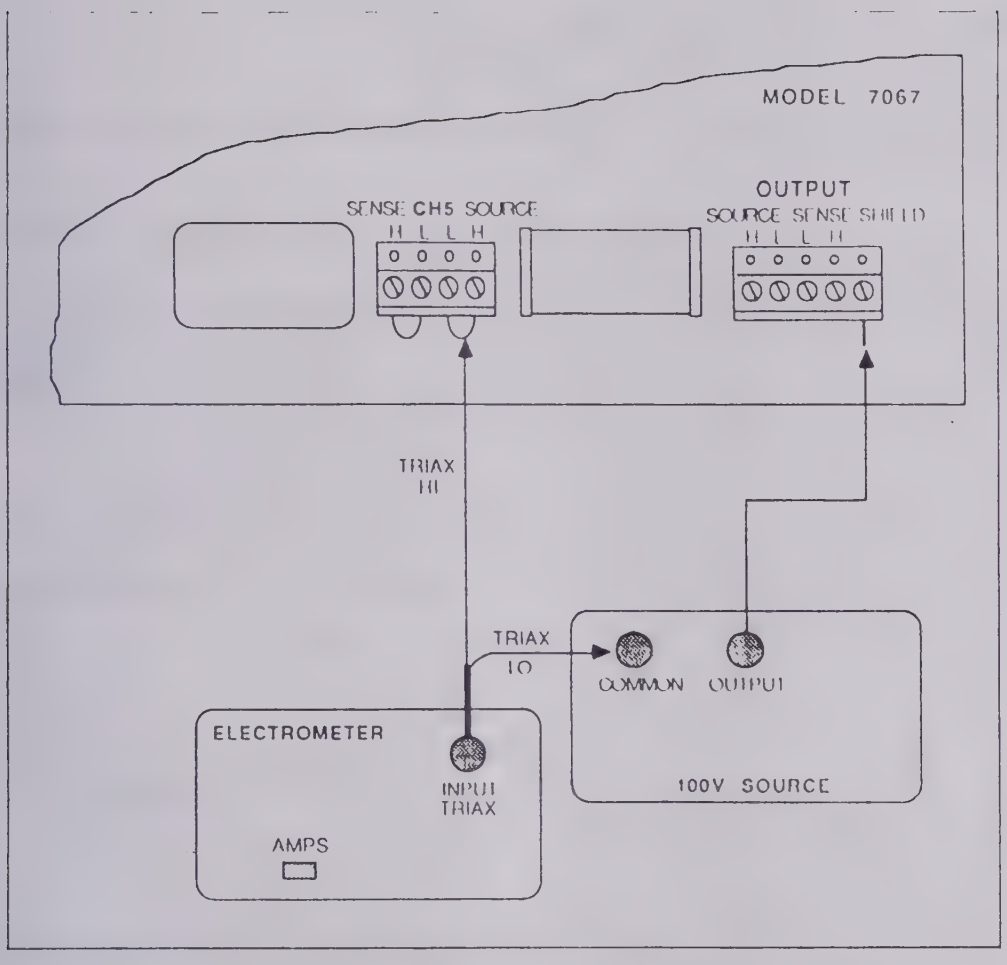


**Figure 3-3. Common Mode Input Isolation**

### 3.4.3 Input Isolation, Differential

This test measures the leakage current between a channel's high and low connections.

1. Set up the equipment as shown in Figure 3-4 (for channel 5). Use the channel's Source High and Low.
2. Insert the Model 7067 into the scanner and set the mainframe to channel mode, step scan mode. Select the channel under test and close it.
3. Set the electrometer to amps and zero check. Program the Model 230 to output 100V. Take the electrometer out of zero check.
4. The electrometer should read less than $1 \times 10^{-7}$A. (Due to the capacitance of the circuit, the offset current may be high until the circuit capacitance is charged up. Wait until the readings settle out.)
5. Using Ohm's law calculate the differential input isolation (leakage resistance). For example:

$$R = E/I \quad (100V/10^{-7}A = 10^{9}\Omega).$$

**NOTE**

With the Model 617 electrometer in V/I mode, the resistance is calculated automatically.

6. Put the Model 230 in standby mode and set the electrometer to zero.
7. Repeat steps 3 through 6 for the channel's Sense High and Low.
8. Repeat steps 2 through 7 for the remaining channels.

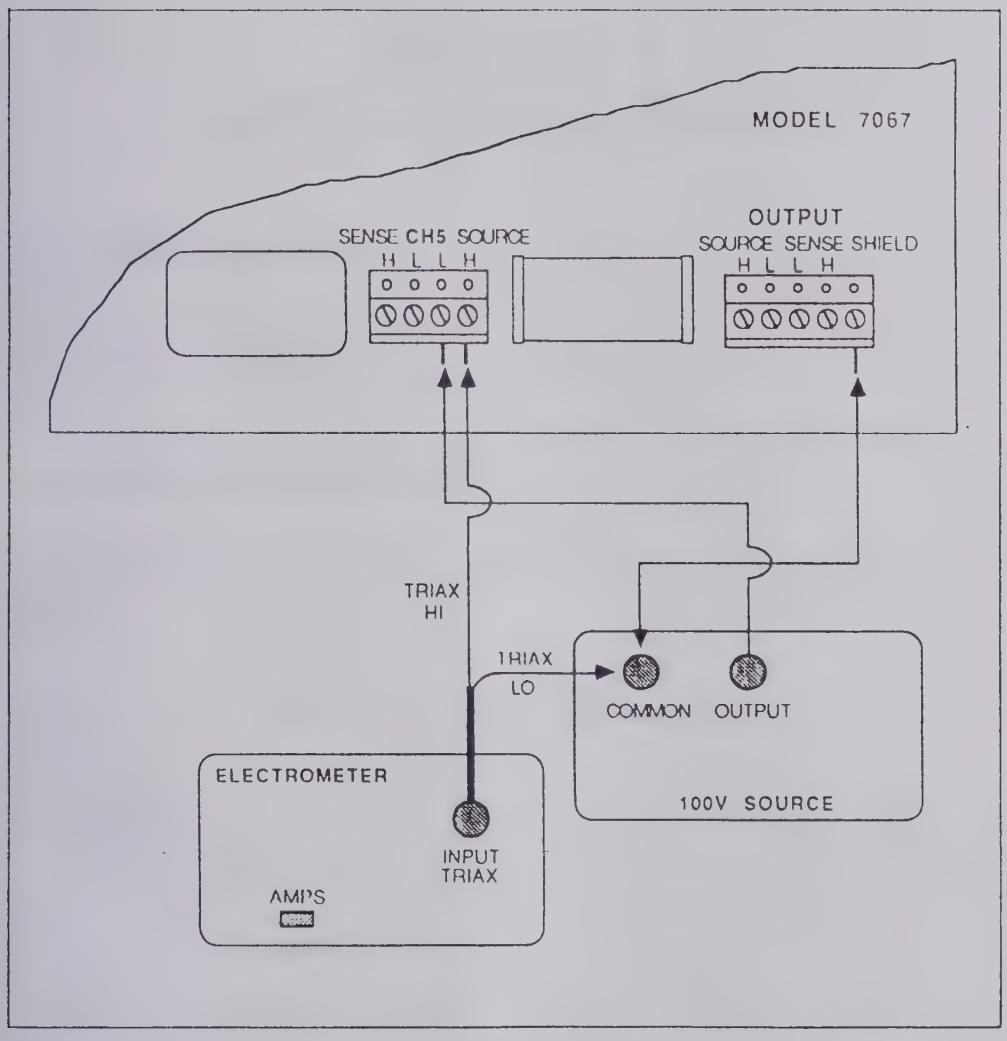


Figure 3-4. Differential Input Isolation

# SECTION 4
# REPLACEABLE PARTS

## 4.1 INTRODUCTION

This section contains replacement parts information, a schematic diagram, and a component layout for the Model 7067.

## 4.2 REPLACEABLE PARTS

Table 4-1 lists parts alphanumerically in the order of their circuit designations.

**Table 4-1. Model 7067 Parts List**

| Circuit Desig. | Description | Sch. Loc. | Keithley Part No. |
|---|---|---|---|
| C1 | Capacitor, 0.1μF | A1 | C-365-.1 |
| CR1 | Rectifier. 1N4006 | B1 | RF-38 |
| J1-J5, J7-J11 | Terminal Block, 4-pin | Sev. | CS-570-4 |
| J12 | Terminal Block, 5-pin | A5 | CS-570-5 |
| K1-K5 | Relay | Sev. | RL-103 |
| K6-K15 | Relay | Sev. | RL-77 |
| K16-K20 | Relay | Sev. | RL-103 |
| | Cable Clamp Assembly, Upper | — | 7055-303-12 |
| | Cable Clamp Assembly, Lower | — | 7055-308 |

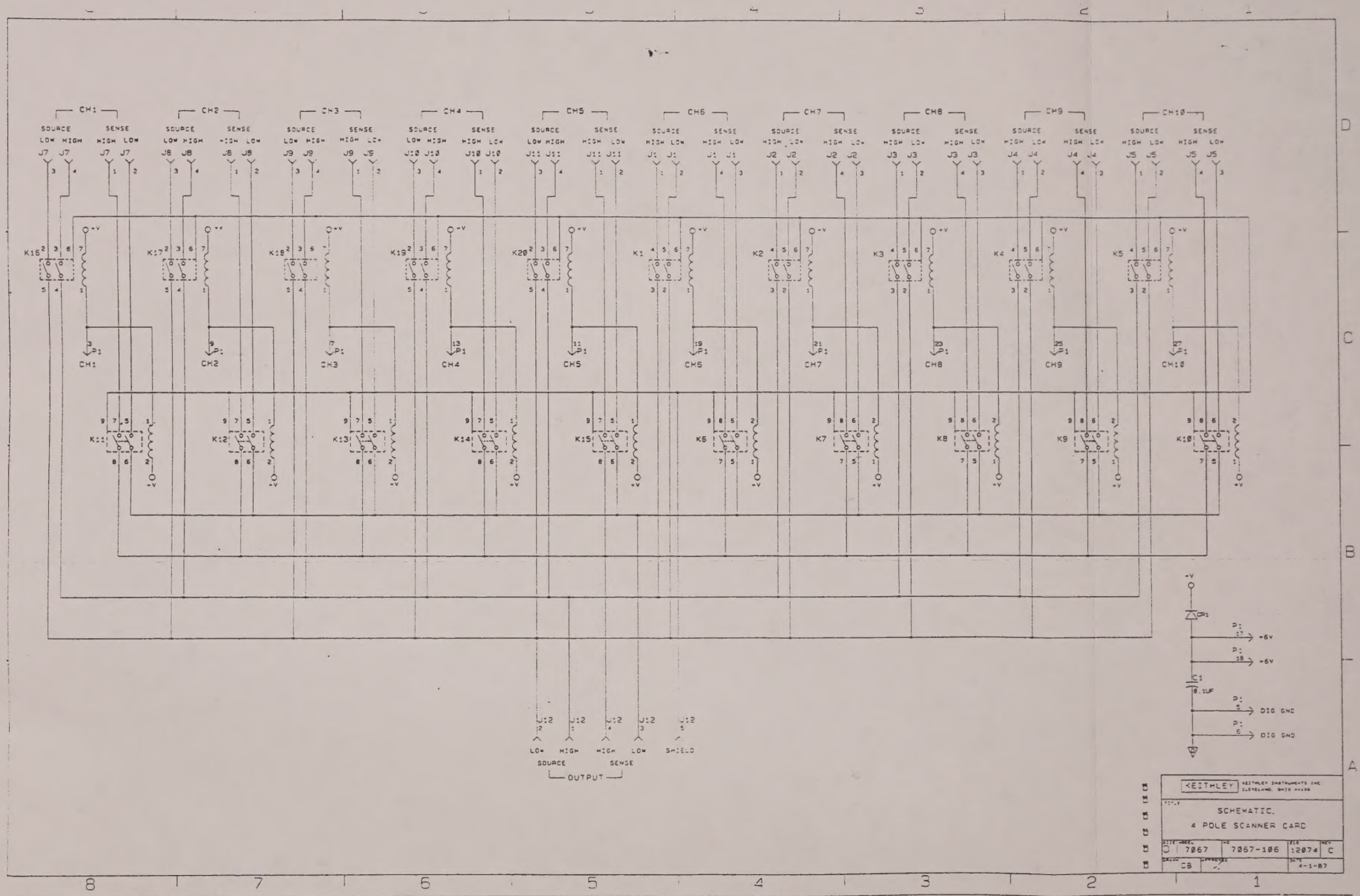


**Figure 4-2. Model 7067 Schematic Diagram**

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# Service Form

Model No. _____ Serial No. _____ Date _____

Name and Telephone No. _____

Company _____

List all control settings, describe problem and check boxes that apply to problem. _____

_____

_____

- ❑ Intermittent
- ❑ IEEE failure
- ❑ Front panel operational
- ❑ Analog output follows display
- ❑ Obvious problem on power-up
- ❑ All ranges or functions are bad
- ❑ Particular range or function bad; specify _____
- ❑ Batteries and fuses are OK
- ❑ Checked all cables

Display or output (check one)

- ❑ Drifts
- ❑ Unstable
- ❑ Overload
- ❑ Unable to zero
- ❑ Will not read applied input

- ❑ Calibration only
- ❑ Data required
- ❑ Certificate of calibration required

(attach any additional sheets as necessary)

Show a block diagram of your measurement system including all instruments connected (whether power is turned on or not). Also, describe signal source.

Where is the measurement being performed? (factory, controlled laboratory, out-of-doors, etc.)

_____

_____

What power line voltage is used? _____ Ambient temperature? _____ °F

Relative humidity? _____ Other? _____

Any additional information. (If special modifications have been made by the user, please describe.)

_____

_____

Be sure to include your name and phone number on this service form.

KEITHLEY

**Keithley Instruments, Inc.**
**Test Instrumentation Group**
28775 Aurora Road
Cleveland, Ohio 44139

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